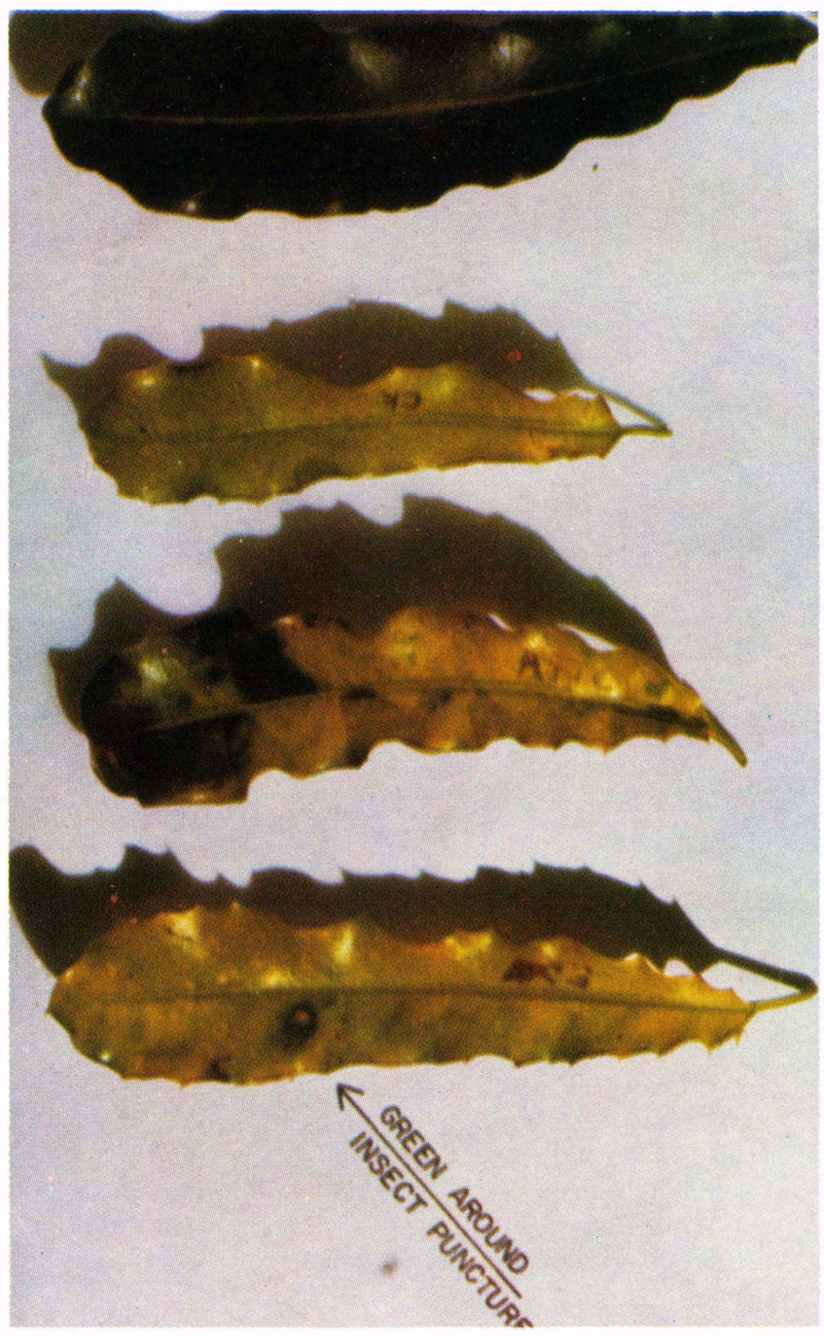
ILLUSTRATED CONCEPTS IN TROPICAL AGRICULTURE
A series prepared by the Department of Agronomy and Soil Science
College of Tropical Agriculture
University of Hawaii

SYMPTOMS OF PLANT MALNUTRITION–INFLUENCE OF NUTRIENT MOBILITY ON IRON DEFICIENCY

Nutrient mobility in plants refers to the ease with which nutrients move. When mobile nutrients are in short supply, they move from old to immature tissues. Young leaves usually contain more mobile nutrients than do old leaves; and deficiency symptoms of mobile nutrients appear first, or are most severe, on old leaves. Nitrogen, potassium and phosphorus are mobile nutrients. The less mobile nutrients are retained by old leaves, while in young leaves nutrient accumulation may be so retarded that severe symptoms develop there. Calcium, manganese, boron and iron are among the less mobile nutrients.

Sometimes deficiency symptoms of immobile nutrients are intensified by an oversupply of another nutrient. An example is phosphorus-induced iron deficiency illustrated in macadamia (*Macadamia integrifolia*) above. The cholorosis resulted from applying 16 pounds phosphorus per tree to the soil. This increased the phosphorus content of leaves, increased growth and created a physiological deficiency of iron even though iron was more concentrated in heavily phosphated trees than in moderately fertilized trees (see table).

The symptoms fit the pattern for immobile nutrients. Leaves which terminated a branch (lower left) were white. Side shoots further back along the branch were pale yellow (middle left) and, finally, yellow with green veins (upper left).



Phosphate-induced iron deficiency is difficult to correct in macadamia. Iron chelate or iron sulfate (acidulated) sprays produced localized greening around insect punctures and along leaf margins (lower right). Perhaps the inefficiency of these sprays was related to high manganese as well as excess phosphorus in leaves. It is probable that small amounts of iron penetrated the thick cuticle of the leaf. Note the fine network of green veins, and especially the green band on either side of the midrib, of the chlorotic leaf which was not sprayed with iron (right, second from top). The normal leaf (upper right) came from a tree which received no iron but only 4 pounds of phosphorus.

The macadamia leaf analyses in the table illustrate the concept discussed above for P (mobile) and for Fe and Mn (relatively immobile).

Nutrient	Leaf Age	Phosphate applied (pounds P/tree) 0	2	4	8	16
P (%)	Recent flush	.057	.063	.066	.079	.105
	Older leaf	.050	.056	.057	.067	.089
Fe (ppm)	Recent flush	62	53	47	46	62
	Older leaf	60	70	57	68	70
Mn (ppm)	Recent flush	2000	1980	1530	670	780
	Older leaf	3330	2830	2660	1490	1330

Robert L. Fox and Robert M. Warner No. 3, 1971